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ACCLIMATED GROWTH RATES OF MEDITERRANEAN *SYNECHCOCCUS* AT THERMOCLINE AND MIXED LAYER TEMPERATURES

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Marine *Synechococcus* are an important component of the picoplankton in the Eastern Mediterranean. These cells are small and rod-shaped, usually about 0.8 X 1.0 μm in size. Because of their distinctive fluorescence characteristics, they can be distinguished from other types of phytoplankton and enumerated by epifluorescence microscopy. These cells are abundant in both the mixed layer and the thermocline of the Eastern Mediterranean, reaching maximum summertime densities of 10^4 per ml (Li et al, 1993). These cells are so small that they are effectively neutrally bouyant in seawater and theoretical considerations suggest that the cells in the mixed layer move between the surface and the top of the thermocline relatively frequently whereas those in the thermocline remain within a relatively narrow depth interval for periods of days or even months (Lande and Wood 1987). Thus, cells in the mixed layer encounter a range of conditions of irriadiance, light quality, and nutrient availability over short time scales, and cells in the thermocline experience regular diurnal fluctionations in irriadiance, but relatively little variation in light quality or nutrient availability over physiologically long time scales. Since this implies that the thermocline and mixed layer are very different kinds of environments for phytoplankton, we have isolated clones of marine *Synechococccus* from the mixed layer and thermocline of a station in the northwestern Levantine Basin in order to determine if there are distinctive ecotypes of marine *Synechococcus* present in these two different regions of the water column.

Strains of marine *Synechococcus* were isolated from water collected at 30 meters and at 100 meters at a station located northwest of Cyprus on the October, 1992, POEM II cruise of the R/V Bilim. This station is located at 36° 30' N and 31° 30' E; the mixed layer was approximately 40 m deep at the time of sampling; and the deep chlorophyll maximum was at about 100 m. Clonal isolates were established by streak dilution on agar plates, and then acclimated to growth in low light at 18°C. As soon as possible, strains were then subcultured and acclimated to growth at either 14°C or 23°C. These temperatures corresponded to the temperature of the mixed layer and thermocline at the station from which the original water samples were collected. At each temperature, triplicate cultures were grown at each of four levels of irradiance. Cultures were maintained in exponential phase for more than ten generations by semi-continuous batch culture. Once the growth rate had been constant over three transfers, the cultures were assumed to be "acclimated" and their growth rate identified as the "acclimated growth rate".

Figure 1 shows the acclimated growth rate of the four most different strains; strains S1 and S11 are from the mixed layer and strains S4 and S6 are from the thermocline. While there are distinct differences in the growth vs. irradiance relationships among the clones, these do not correspond to differences in the site from which the clones were isolated. For example, the two strains which grew the fastest at high light at 14°C were S6, a thermocline strain, and S11, a strain from the mixed layer. All the strains had virtually identical growth rates in high light at 23°C. When growing under conditions of high temperature and irradiance, the strains isolated from the thermocline did not appear to be at a disadvantage when their growth rates were compared to those of the mixed layer strains growing under the same conditions.

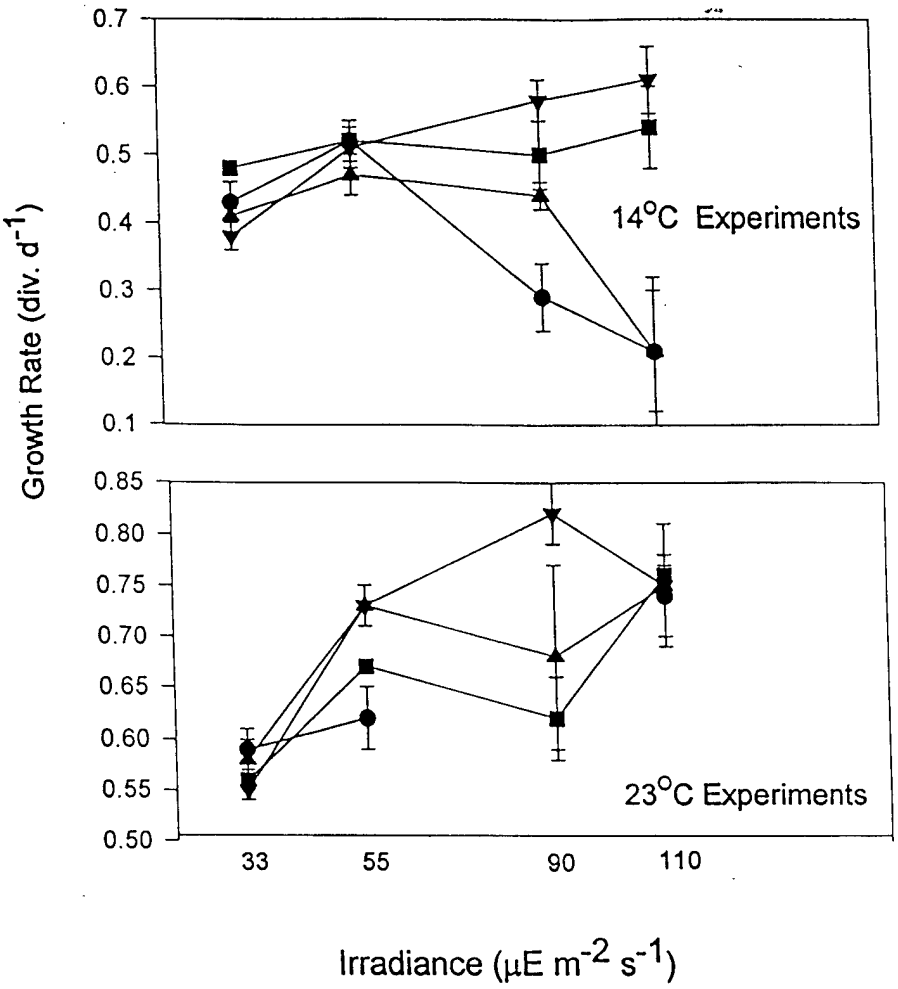

FIGURE 1. Acclimated growth rates of the four marine *Synechococcus* strains showing the most different responses to temperature and irradiance levels. Strains S-1 (—●—) and S11 (—■—) were isolated from the mixed layer and strains S4 (—▲—) and S6 (—▼—) were isolated from the thermocline.

The clones all showed higher growth rates at 23°C than at 14°C, regardless of whether they were TC or ML isolates. The highest growth rates observed at 14°C (0.60 day^{-1}) would probably not be observed in the seasonal thermocline of the Eastern Mediterranean since they only occurred at levels of irradiance unlikely to occur in the thermocline. Growth rates at lower, subsaturating, irradiance levels ranged from 0.4 to 0.5 d^{-1}. At 23°C, growth rates were always higher than 0.55 d^{-1}, regardless of irradiance level, and they reached as high as 0.8 d^{-1} in one clone. Overall, average growth rates for the four clones in high light at 23°C appear to be about 0.75 d^{-1}.

In order to create simulation models of primary production in the Eastern Mediterranean, it may be helpful to consider the marine *Synechococcus* as a separate group, distinct from other members of the phytoplankton. They have different light requirements and different responses to the submarine light field than many other types of phytoplankton (cf. Wood

1985, Glover et al. 1986,87), and can be much more easily enumerated than any other group of picophytoplankton. Our results are not consistent with the hypothesis that thermocline and mixed layer *Synechococcus* communities are dominated by distinct thermocline and mixed layer ecotypes, but they do suggest that temperature may be at least as important a determinant of *Synechococcus* growth rate as irradiance. Thus, it should be possible to treat the *Synechococcus* as a single compartment for which growth and productivity can be modelled as a function of irradiance and temperature. Incorporation of grazing losses may, however, require further separation of the group into mixed layer and thermocline compartments because of depth-dependent segregation of micro-grazers into communities with different kinds of selectivity and efficiency.

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